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THE SYNTHESIS OF MINERALS AND ROCKS.

Synthèse des mineraux et des roches; avec une planche en photochromie. Par *F. Fouqué et A. Michel-Lévy.* Paris, *Masson*, 1882. 423 p. 8°.

THE great value of synthesis in any department of scientific inquiry is undoubted; but the difficulties connected with it are in most cases so discouraging, and the results obtained so unsatisfactory, that an additional interest attaches to experiments so brilliantly successful as those recently performed in Paris by Messrs. Fouqué and Lévy in the artificial reproduction of volcanic rocks. It is to the French that we owe almost every thing that has thus far been accomplished in synthetical mineralogy; and we can but hail with delight the achievements of these two gentlemen, who have added new lustre to the French name by carrying the synthesis one step farther. They have produced in the laboratory, not only a large number of the rock-making minerals, but have produced them in their natural associations, as they go to make up integral parts of the earth's surface.

The book before us is to a great extent a compilation, giving a bibliography, and a short *résumé* of the processes by which mineral species have thus far been artificially obtained. Valuable as this is for reference, it is in the first eighty pages of the work that its principal interest lies. Here we are presented with a systematic account of the authors' own experiments, which it has heretofore been very difficult to obtain from the numerous short articles scattered through various periodicals which have appeared during the past four years.

The first chapter is a general introduction, containing, first, the five conditions which an artificial product must fulfil in order to be a successful synthesis. Then are noted several circumstances, which, during late years, have been especially conducive to synthetical investigations in the department of mineralogy and geology, and the great benefit which these sciences have derived from such investigations. A classification of the various methods made use of in the artificial reproduction of minerals follows; and the chapter closes with an arrangement of the crystalline constituents of the earth's crust, for purposes in hand, in four categories, as follows: —

1°. *Volcanic* (basic) *rocks;* i.e., plagioclase rocks, and those free from felspar.

2°. *Acidic rocks;* i.e., those containing quartz or orthoclase (granite, rhyolite, etc.).

3°. *The crystalline schists* (gneiss, mica-schist, etc.).

4°. *Mineral veins.*

The minerals of the first of these categories, and their natural associations, have nearly all been reproduced by simple fusion; those of the last, by volatilization or solution. Those of the remaining two categories have not yet been artificially reproduced with entire success.

The second chapter is devoted to the account of the authors' own experiments, and a discussion of their results. This is preceded by a brief history of what had been before accomplished in this line. Attempts to reproduce mineral associations by means of superheated water had yielded nothing satisfactory, and even the method of pure igneous fusion, so often tried, had only produced results that caused the most eminent geologists, in most recent years, to declare that Nature must employ far different means in the formation of her lavas than stands at the command of the laboratory.

The apparatus with which the syntheses were performed was very simple. The substances to be fused were placed in platinum crucibles, incased in coverings of fireclay. These were heated by a blast of ordinary illuminating-gas in a Leclerc and Forquignon furnace. Four grades of temperature were made use of, designated by their numbers as follows: —

No. 1. Melting-point of platinum. Sufficient to reduce anorthite, leucite, and olivine to a vitreous mass.

No. 2. Melting-point of steel, also of all the felspars except anorthite, and of the bisilicates.

No. 3. Between the melting-points of steel and copper. Pyroxene and nepheline fuse readily.

No. 4. Where copper fuses with difficulty.

The associations of various rock-making minerals were readily obtained by the employment of the principle, already well known to Hall, *that the fusing-point of a crystallized silicate is in general higher than that of the same chemical compound in an amorphous state.* If, therefore, a melted silicate glass be held for a time at a temperature between the fusing-point of some mineral whose constituents it contain, and its glass, crystals of this mineral will form in the molten mass; now, if the temperature be lowered sufficiently, the next less easily fusible mineral may be obtained; and so on. It is then the rule that *the minerals crystallize out of the magma in the inverse order of their fusibility.* This rule is abundantly verified for the class of rocks capable of synthesis

by fusion, both by the study of natural and artificial products, with a few apparent exceptions, which receive a special explanation.

By a judicious combination of substances and temperatures, the authors succeeded in obtaining eleven distinct mineral associations, almost exactly reproducing, even in the minuest details of structure, as many natural rock types.

These are as follows: 1°. *Augite* (*oligoclase*) *andesite*, 2°. *Augite* (*labrador*) *andesite*, 3°. *Augite* (*anorthite*) *andesite* (all produced by single fusion at temperature No. 3); time three days. 4°. *Basalt*. Two successive stages of fusion were necessary to produce this rock. Temperature No. 2 produced in forty-eight hours numerous crystals of olivine embedded in a glassy matrix, which was altered into a crystalline mass of labradorite and augite microliths by being again subjected for an equal length of time to temperature No. 4. 5°. *Nephelinite* was produced in forty-eight hours at temperature No. 4. 6°. *Leucitite* was obtained after three days' fusion at temperature No. 2. 7°. *Leucititephrite* produced by double fusion exactly like basalt. 8°. *Lherzolite*, 9°. *Meteorites free from felspar*, and 10°. *Felspathic meteorites*, though quite successful so far as the mineral associations were concerned, showed certain variations from the natural products in their structure. No synthesis was perhaps so interesting as that of 11°. *Diabase*, with the so-called 'ophitic' structure. This structure consists, as is well known, of irregular masses of pyroxene filling the spaces between the lath-shaped crystals of plagioclase. It was found to be impossible to reproduce this structure with oligoclase or labradorite, on account of their comparatively low fusing-point. By means of a double fusion with anorthite, it was, however, successfully accomplished.

Scarcely less interesting than these positive results are the conclusions derived from the authors' negative experiments. It was found impossible to obtain the acid rocks, i.e., those containing either quartz, albite, orthoclase, muscovite, biotite, or amphibole, by purely igneous fusion. These minerals either produced an amorphous mass, or passed into other combinations giving rise to species already obtained; e.g., hornblende, when melted, crystallized as pyroxene. Thus the very important conclusion is reached, that the acid rocks owe their origin to some other agency than simple fusion.

Under the head of the synthesis of minerals, the authors' experiments in fusing mixtures of felspars are worthy of special notice as being directly opposed to the now generally accepted theory of Tschermak, that the triclinic felspars form an isomorphous series. Fouqué and Lévy found it impossible to obtain crystals of intermediate members, as only well-defined microliths of either oligoclase, labradorite, or anorthite, appeared, varying in their relative proportions with the mixtures fused. Also of especial interest are their artificial production of felspars with lead, barium, and strontian as bases.

THE GEOLOGY OF NATAL.

Natal. Department of mines. Report upon the coal-fields of Klip River, Weenan, Umvoti, and Victoria counties, together with tabulated statement of results obtained from a series of trials of colonial coal upon the Natal government railways. By F. W. North. London, *Harrison, pr.*, 1881. 1, 66 p., (49) pl., etc. f°.

This report contains two maps, showing the distribution of the coal-fields of the colony of Natal, and a description of 72 sections occurring in them, 70 of which are illustrated by diagrams. There are also two horizontal sections given, — one from Buffalo River to the Drakensberg Mountains, and the other from Buffalo River to Elands Laagte.

Mr. North estimates the actual area of the Natal coal-field, where he has found workable coal-seams at the surface, at about 1,100 □ miles, situated entirely in Klip River county. To this he adds 250 □ miles for the region between the Ingagani River and the Drakensberg Mountains, which he considers the coal measures underlie. The workable seams vary from 4 to 10 feet in thickness, and are of several qualities. Assuming an average thickness of 4 feet, and allowing a deduction of 50 per cent for faults, worthless coal, and barren ground, he estimates the whole at 2,073,000,000 tons, divided into, —

	Tons.
Anthracite, similar to Gladstone . . .	518,400,000
Semi-bituminous, similar to Walmesley,	518,400,000
Bituminous, similar to Dundee coal-fields and Lenox sections	518,400,000
Free-burning bituminous coal of the same character as No. 44 Crown lands and Lenoxton, Newcastle .	518,400,000
Total	2,073,600,000

Mr. North considers these coals superior in quality to those of Cape Colony. A number of analyses of them have been made by Dr. Frankland and Dr. Hahn. There are also many beds of iron ore: the one from Prestwick is an intimate mixture of magnetic iron ore and